



Effect of Intercropping Sesame (*Sesamum indicum*) with Green Gram (*Vigna radiata* L. Wilczek) on Crop Phonology and Yield in Humera, Western Tigray, Ethiopia

Dargie Girmay^{1*}

¹*Department of Crop, Ethiopian Institute of Agricultural Research, Tigray Agricultural Research Institute, Humera Agricultural Research Center, P.O. Box 62, Humera, Tigray, Ethiopia.*

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/APRJ/2020/v4i230080

Editor(s):

(1) Dr. Langa Tembo, University of Zambia, Zambia.

Reviewers:

(1) M. Usman, Federal College of Education, Nigeria.

(2) Yesim Togay, Mugla S. K. University, Turkey.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/56998>

Received 08 March 2020

Accepted 14 May 2020

Published 24 May 2020

Original Research Article

ABSTRACT

Cropping system in the study area is by far dominated by sesame sole cropping, which resulted in low productivity, pest prevalence, poor soil fertility and yield. A study was conducted to evaluate the productivity of sesame varieties intercropped with green gram in factorial arrangement at kafta-humera during 2017/18 cropping season. Two factorial experiment namely, (i) cropping system at two levels (sole and intercropping), (ii) two sesame varieties (setit1 and local) and was conducted in randomized complete block design replicated three times.

The results showed that yield of sesame and green gram were affected considerably by cropping system. Highest and significant grain yields of both sesame varieties were recorded in the pure stands (6.70 qt/ha and 5.30 qt/ha for setit1 and local) respectively. On the contrary, lowest yield was obtained (4.3 q/ha and 5 q/ha) under intercropped local and setit1 respectively. Moreover, sole green gram gained a significant higher seed yield (13.2 qt/ha) over intercropped greengram with local (5.1 qt/ha) and intercropped greengram with setit1 (4.7 qt/ha) treatments.

*Corresponding author: E-mail: dargiegirmay1974@gmail.com;

Keywords: Grain yield; green gram; intercropping; sole cropping; sesame.

1. INTRODUCTION

Sesame is a warm season oil crop which performs well in slightly acid to alkaline soils (pH 5-8) with moderate fertility [1]. The optimum temperature for growth is in the range of 27–35°C (Weiss, 2000). The total amount of water required for growing sesame ranges from 600 to 1000 mm, depending on the cultivar and the climatic [2].

In Ethiopia, sesame is growing mainly in Welega (with red/brown seeds), Metema (with less white seeds), and Humera (with white, tasty seeds, which makes it preferable among the other seeds of sesame [3]. The Ethiopian Central Statistical Agency, CSA, (2018) report showed that sesame is an important crop produced in Ethiopia for oilseed production and it was ranked first in total production from oil crops. In Ethiopia, oilseed is the 3rd largest crop sector in area coverage after cereals and pulses, and sesame ranks 1st from the oil seeds sectors with total land coverage of 388,245ha in 2016/17 cropping season and estimated production of about 274217 metric tons [4]. Sesame is used in wide range of applications [5]. The most important ones are; Edible oil, Confectionery, Tahini and Halva industry.

Cropping system in the study area is by far dominated by sesame sole cropping year after year due to its highest price in the global market. However, due to this repeated cropping of sesame year after year on the same land, soil fertility and pest abundance became a series challenge of sesame production in the study area [6]. Moreover, sesame price in the global market is decreased (seventh annual conference on pulses, oil seeds and spices, 2017). Similarly, MOT (2016) report showed that the price of Humera/Gondar sesame, the reference price for international markets being traded on the Ethiopia Commodity Exchange (ECX) has dropped from about \$1,360 per metric ton in January 2015 to nearly \$860 per metric in January 2016.

Thus, intercropping sesame with green gram could be an option to the producers to overcome the challenges mentioned. Moreover, the poor nitrogen content can be resolved by intercropping sesame with green gram due to the ability of the legume to fix atmospheric nitrogen. The objective of this study was to determine the

effect of intercropping of sesame with green gram on phonology, pest prevalence and yield.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The research site, Kafta-Humera district, as presented in (Fig. 1) is located at 14°15' N latitude and 36°37' E longitude, with an average altitude of 609 meters above sea level. The location of the study area has a common boundary with Eritrea in north, Laelay Adyabo and Tsegedea weredas in the east, Amhara Regional State in the south, and Sudan in the west [7]. The mean annual rainfall of the area, with characteristics of erratic and uneven distribution, concentrated during June to September is 581.2 mm; though, the annual amount of rainfall during the cropping season (2017) was 443 mm. The area is also characterized by hot temperature and high evaporation; with an average monthly temperature of 28.2°C. The poor distribution of the rainfall coupled with high evaporation makes the area vulnerable to terminal moisture stress. The dominant soil type is black Vertisol; characterized by very deep (>150 cm) clay texture (40-60% clay content) with low OM content (<2%).

2.2 Treatments and Experimental Design

2.2.1 Planting material

Nationally released sesame varieties called setit1 and local sesame and released green gram variety called arkebe was used in the experiment (Table 1). Setit1 was recommended for its earliness, white color and high yielding traits by Humera Agricultural research Center during 2011 cropping season and the local sesame is less branched, erect and multi loculed locally available variety; while green gram, Arkebe variety was released in 2011 because of its earliness and drought tolerant.

2.2.2 The experimental design

Tow factorial experiment arranged in randomized complete block design (RCBD) was used in the study. Two sesame varieties and two cropping system as shown in (Table 2) were replicated three times. The total plot size was 4.8 m * 2.5 m

= 12 m² and distance between replication and plots were 1.5 m and 1 m respectively. Net or harvestable plot area was 0.4 m between rows * 10 rows * 2.5 m row length = 10 m². The total area of the experimental farmland was therefore 28 m width * 10.5 m length.

Sesame varieties were sown in July 21/ 2017 at a seed rate of 2.5 kg/ha while green gram variety, Arkebe was planted in between sesame rows at a seed rate of 30 kg/ha,

As a control both the two varieties of sesame and green gram were sown Green gram was sown in August 04 /09/2017; two weeks later to sesame planting. Plant to plant spacing was maintained to be 10 cm for both sesame and green gram varieties as per the recommendation. 100 kg /ha of UREA and 50 kg/ha of DAP fertilizers were used according to the recommendation given earlier for the area.

2.3 Data Collection

Data on days to 50% emergency, 50% flowering and 90% physiological maturity were determined by observation; the time taken from sowing the seeds to the specific phenological stages. Yield data was taken from the plot then changed to per hectare bases.

Soil sampling and analysis was done before planting the crop in plots. Soil samples from the experimental fields of the study sites were taken randomly in a W-shaped pattern. Ten samples were taken using an auger from each arm of the W-shaped lines of the field to a depth of 0-30 cm. Thus, 30 soil cores were taken from the whole area and thoroughly mixed. From this mixture, a sample weighting 1 kg was taken and before analysis, the sample soil was air-dried, grounded and sieved through a 2-mm sieve mesh.

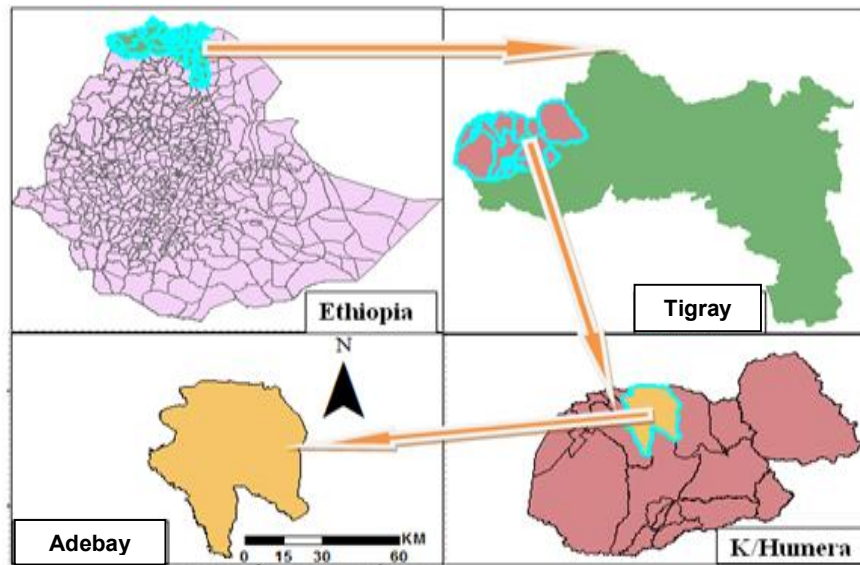


Fig. 1. Map of the study area

Table 1. Description of the planting materials

Crop	Variety name	Source	Days to maturity	Plant height (cm)	Seed color	Yield (qt/ha)	Year of release	Oil content (%)	Days to maturity
Sesame	Setit1	HUARC	85-95	130-140	White	4.5-8	2011	52-54	100-110
Sesame	Local (mobile)	Locally available	90-105	125-130	White	4-6.5	-		
Greengram	Arkebe	HUARC	63-70	45-50	Green	15-20	2011		65-72

Source: Humera Agricultural Research Center, HUARC, (2014) and MoARD, crop variety register book, (1990-2010)

Table 2. Treatment factors and levels

Treatment factors	Levels
variety	Setit1 Local
Cropping system	Sole Intercropping

The composite soil sample was analysed for selected physio chemical properties, i.e. for soil texture, soil pH, total nitrogen (N), organic matter content (OM), available phosphorus (P), cation exchangeable capacity (CEC) and exchangeable potassium using the appropriate laboratory procedures at Adiet Agricultural Research Centre Soil Laboratory.

2.4 Data Analysis

All data was analyzed with the Analysis of Variance (ANOVA) using the Gen stat 14 statistical package. The Least Significant Difference (LSD) procedure was used to determine treatment differences. The significant differences between the treatments were

compared with the critical difference at a 5% significance level.

3. RESULTS AND DISCUSSION

3.1 Soil Physical and Chemical Properties

Results from prior to planting soil analysis revealed that the soil of the experimental field was classified as clay with alkaline characteristic. As presented in (Table 3), the soil has low organic matter, low total N, and low available p. Thus, as the result in the table below (Table 3) showed the soil needs application of synthetic nitrogen and phosphorus fertilizers for a better yield.

Table 3. Laboratory results on soil physical and chemical properties of the study area

Soil Characteristics	Value	Rating	Reference
pH 1:2.5 (H ₂ O)	8.5	Basic	FAO (2008)
Total N (%)	0.8	Low	Tekalign (1991)
Organic matter (%)	0.84	Low	Roy et al. (2006)
Available P (mg kg ⁻¹)	2.65	Low	FAO (2008)
Exchangeable K (Cmol (+) kg ⁻¹)	16.25	Low	FAO (2006)
CEC (cmol (+)kg ⁻¹)	0.2	Low	Hazelton and Murphy (2007)
Texture	Clay		
Sand (%)	19		
Silt (%)	14		
Clay (%)	67		

Table 4. Effect of variety and cropping system on days to Emergency, Flowering and Maturity of sesame and green gram

Variety	Sesame			Green gram		
	50% DE	50% DF	90% DM	50% DE	50% DF	90% DM
Mobile	6	43*	88	-	-	-
Setit1	4	39	85	-	-	-
LSD	0.8	1.5	0.9	-	-	-
Cropping system						
Intercropping	5 ^{NG}	41 ^{NG}	86	5.5 ^{NG}	32.2 ^{NG}	60.8 ^{NG}
Sole	5 ^{NG}	41 ^{NG}	86.8	5.8 ^{NG}	32.4 ^{NG}	68.2 ^{NG}
LSD	1.3	2.5	0.9	0.83	1.384	10.86
CV	16.1	3.6	1.6	17.5	5.0	19.3

DE= days to emergency, DF = days to flowering, DM= days to maturity, LSD=least significant difference, CV= coefficient of variation, NG = none significance

3.2 Crop Phonology

The current finding showed significant effect ($p=0.05$) of variety on 50% emergency, 50% flowering and 90% physiological maturity of sesame varieties. Setit1 showed statistically shorter period of the mentioned parameters over local. Local sesame took relatively longer period than setit1. Local and setit1 scored (6, 4), (43, 39) and (88, 85) days for 50% emergency, 50% flowering and 90% physiological maturity respectively (Table 4). On the other hand, cropping system and row spacing did not show statistical difference on sesame varieties as well as green gram on plant phonology. The variation in phonology between sesame varieties might be due to difference in their genetic makeup.

Similar maturity period of sesame and green gram under intercrop compared to sole which is in agreement to the present observation was noted by [8]. Studies on maize/bean intercropping [9], sorghum/green gram intercropping [10] and maize/common bean intercropping [11] also reported that the phonology of the cereal component was not significantly affected by the associated legume components.

3.3 Plant Height

Analysis of variance for plant height of sesame showed a statistical significance difference ($p=0.05$) due to variety; but, cropping system and the interaction was not significant as presented in Table 5). Setit1 scored a significant maximum height (129 cm) over local (125 cm). This variation might be due to genetic variation of the varieties which setit1 is longer than local.

Similarly, the analysis of variance ($P=0.05$) on plant height of green gram showed that there was no significance difference between cropping system and the interaction. But, relatively, sole green gram scored maximum (42.2 cm) plant height. Thus, plant height of green gram did not significantly influenced by intercropping of both the two sesame varieties.

Similar results were reported by [12]: which none significant plant height of sesame under different intercropping treatments as compared to sole sesame. In line with the present study, [13] also reported none significance of influence of associated cultures in average plant height of sesame. Considerably higher, but none significant plant height of sesame under different

intercropping treatments as compared to sole sesame was also reported by [14] and on maize/bean intercropping.

3.4 Number of Branches per Plant

The current result indicated that number of branch plant⁻¹ of sesame was affected by variety and cropping system ($p=0.05$); however, the interaction effects were not significant (Table 5). Setit1 recorded a significant higher number of branches per plant (3.0) over local (2.0). Moreover, sesame number of branches per plant was affected by cropping system to a significance level which sole crop scored higher. Similarly, green gram number of branches per plant was affected significantly by cropping system. Green gram grown alone produced a significant greater number of branches per plant (4.5) over the intercropped one (4).

Reduction in number of branches per plant in the intercropped treatments might be due to more competition between plants (Sesame as well as intercrops) for light, space, water and nutrients.

These results are in line with the findings of [15] who reported a significant reduction in branches per plant of green gram when intercropped in cotton compared to sole green gram. The earlier findings of [16] which studied that highest number of branches per plant (3.9) were obtained from sole sesame in green gram /sesame intercropping also supported the present result.

3.5 Grain Yield of Sesame and Green Gram

Grain yield of sesame was greatly affected by the interaction of variety and cropping system. Sole setit1 gained a significant higher yield (6.7 qt/ha) over all interactions followed by sole local (5.3 qt/ha). Intercropped local and setit1 scored significance lower yield (4.3 qt/ha and 5 qt/ha) over the sole crops respectively. The reduction in yield of sesame under intercropping treatments could be assigned to lower values of yield attributes viz., number of capsule per plant, number of seeds per capsule and test weight under intercropping treatments resulted from poor plant growth due to competition effect between sesame and intercrops for resources like sun light, space, moisture and plant nutrients.

Table 5. Effects of variety and cropping system on sesame and green gram number of branches plant⁻¹ and plant height at Humera, Western Tigray in 2017

Treatment	Sesame		Greengram	
	NBC plant ⁻¹	PHT (cm)	NBC plant ⁻¹	PHT (cm)
Mobile	2	125	-	-
Setit1	3	129	-	-
LSD	0.5	1.2	-	-
Cropping system				
Intercropping	2	127 ^{NG}	4	43.2 ^{NG}
Sole	3	127 ^{NG}	4.5*	44 ^{NG}
LSD	0.9	2.1	0.32	2.2
CV	20.5	1	8.8	6.0

NBC plant⁻¹, Number of branch per plant, PHT = Plant height LSD=least significant difference, CV= coefficient of variation, NG = none significance

Table 6. Interaction effects of variety and cropping system on yield of sesame and greengram

Treatments	Yield of sesame(q/ha)	Yield of greengram(q/ha)
Intercrop Local	4.3 ^d	5.1
Sole local	5.3 ^{bc}	-
Intercrop Setit1	5c	4.7
Sole setit1	6.7 ^a	-
Sole greengram		13.2
LSD	0.69	1.2
CV	10.4	12.8

1q/ha is equal to 100 kg/ha

Grain yield of green gram was significantly different between cropping systems. Sole green gram recorded a significant maximum yield of (13.2q.ha-1) over the intercropped treatments (6.7 qt/ha) as indicated in (Table 6).

Similar result by [17] was reported: among the intercropping systems, sesame produced higher seed yield when it was alone compared intercropped with green gram. Reduction in grain yield of sesame intercropped to legume intercropping was again reported by [18], which agrees with the present result.

Reduction in yield of intercropped green gram can be ascribed to less number of branches per plant, less number of seeds per pod, lower 1000 seed weight and less number of pods per plant than sole green gram. There is a higher competition for different important resources in the intercrop than the sole crops [19]. Moreover, it could also be due to suppressing effects of the tall and highly branched sesame varieties on its vigorosity.

Similarly, [20] in the same way reported a significant lower grain yield of soybean under intercropping with sorghum as compared with the pure stand.

4. CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Results of soil sample analysis showed that the study area has low soil fertility status. Days to emergency, flowering, maturity and plant height was not significantly different due to cropping system but, sesame varieties showed statistical difference might be due to genetic difference. Number of branch plant⁻¹ of sesame was affected by variety and cropping system while the interaction was not significant. Similarly, Green gram number of branches per plant was affected significantly by cropping system.

Grain yield of both sesame and green gram decreased in the intercropping compared to sole cropping. The grain yields of setit1, local and green gram were highest in the respective pure stands (6.7 qt/ha, 5 qt/ha and 13.2 qt/ha) respectively, attributable to the absence of inter-specific competition. Sole crops of both sesame and greengram yielded statistically higher grain yield over all other consequent interactions.

4.2 Recommendation

Small scale farmers and investors who grow sesame year after year in the study area are greatly recommended to practice growing of green gram to gain higher net economic return. Finally, future research directions should be focused on verifying the current investigation across years and locations in order to reach a conclusive result.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Langham D, Riney J, Smith G, Wiemers T, Peeper D and Speed T. Sesame growers guide. Sesaco Corporation; 2008.
Available:www.sesaco.net
2. Carlsson A, Chanana N, Gudu S, Suh M, Were B. Sesame In: Kole C, et al (Eds). Compendium of transgenic crop plant - Transgenic oilseed crops: Texas, USA. Wiley Blackwell. 2008;227-246.
3. Central statistical agency. Agricultural Sample Survey 2012/2013 (2005 E.C.), Report on area and Production of Crops (Private Peasant Holdings: Meher Season). Statistical Bulletin, Addis Ababa. 2018;1.
4. United Nations conference on trade and development. National green export review of Ethiopia: Leather and sesame seeds; 2017.
5. Wijnands J, Biersteker J, Hiel R. Oilseeds business opportunities in Ethiopia: Survey report, Ministry of Agriculture, Nature and Food Quality, The Netherlands, The Hague. 2007;8-20.
6. Sorsa, Debela, Gelalcha. Sesame trade arrangements, costs and risks in Ethiopia: A baseline survey; 2009.
7. ENUPI, Report on development plan of Humera Town, Tigray: Ethiopian National Urban Planning Institute (ENUPI) (Unpublished); 2002.
8. Norman D. The rationalizing of intercropping: African environment 2/3. 2002;(4/1):97-109.
9. Rajesh K, Narender Reddy, Kumar Reddy and Gopal Singh. Effect of plant growth regulating compounds on chlorophyll, photosynthetic rate and yield of green gram: Intern. J. Develop. Res. 2014;4(5): 1110-1112.
10. Ali E, Mahmoud A. Effect of foliar spray by different salicylic acid and zinc Concentrations on seed yield and yield components of mungbean in sandy soil: Asian, J. Crop Sci. As a pre-rice crop on water log-prone rice lands. J. Agric. Water Management. 2013;5(1):3340.
11. Sharma, Pushp, Singh, Guriqbal, Bains T. Influence of foliar fertilization on sink strength, growth and grain yield in mungbean (*Vigna radiata* L Wilczek): Eco. Environ. & Cons. 2014;20(4): 16131617.
12. Meena N, Sharma K, Yadav B, Jana B. Response of mungbean (*Vigna radiata* L.) to FYM and zinc 138 enriched FYM in loamy sand soil of Jobner: Intern. J. Dev. Res. 2014;5(9):5478-5482.
13. Samui R, Sengupta S, Roy B. Effect of intercropping on yield and economics of sesame and green gram: J. Oilseeds Res. 1993;10(1):20-24.
14. Krishna M, Reddy A. Studies on intercropping green gram in summer sesame (*Sesamum indicum* L): J. Oilseeds Res. 2005;22(1):201-203.
15. Khan M. Bio-economic efficiency of different cotton based inter cropping systems: Ph.D. Thesis, Dept. of Agronomy, Univ. Agri. Faisalabad, Pakistan; 2000.
16. Sarkar R, Pramanik D. Effect of planting pattern in sesame + mngbean intercropping systems: Indian Agriculturist 36(1): 19-24. Field Crop Absttract. 2003;47(2):1142-1994.
17. Kumar A, Thakur K. Production potential and economic feasibility of sesame-based intercropping with legumes under rain fed conditions: Indian Journal of Agricultural sciences. 2006;76(3):183-189.
18. Chandrasekhar C, Bangarusamy U. Maximizing the yield of mung bean by foliar application of growth regulating chemicals and nutrients: Madras Agric. J. 2003;90(1-3):142.
19. Bhatti I, Ahmed R, Nazir M. Agronomic traits of sesame as affected by grain Intercropping and planting pattern.

- Pakistan Journal of Agricultural Sciences. 2010;42:56-60.
20. Tamiru Hirpa. Effect of intercrop row arrangement on maize and haricot bean productivity and the residual soil: World Journal of Agricultural Sciences. 2014;2(4):069-077.
Available:<http://wsrjournals.org/journal/wjas>
[ISSN: 2329-9312 ©2014]

© 2020 Girmay; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/56998>